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ON THE
RECLAMATION OF WASTE LANDS
IN THE
CLYDE ESTUARY,
CONSIDERED IN RELATION TO THE DISPOSAL
OF THE SEWAGE OF GLASGOW.

BY
ALEXANDER FREW, C.E.

[READ BEFORE THE ARCHITECTURAL SECTION, 16TH DECEMBER, 1889.]

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On the Reclamation of Waste Lands in the Clyde Estuary, considered in relation to the Disposal of the Sewage of Glasgow.
By ALEXANDER FREW, C.E.

[Read before the Architectural Section, 16th December, 1889.]

(WITH MAP OF CLYDE ESTUARY.)

Two very important and apparently perplexing questions are at present being forced upon the attention of the citizens of Glasgow, and the public voice seems to be gaining strength in its demand that the authorities shall at once look these questions straight in the face, and make a real effort to solve them in a practical and satisfactory manner.

I say a real effort, because have there not been many partial efforts made in the direction of the solution of these questions, but all of which have attained their maximum when the stage of a report has been reached.

The questions to which we refer, and which are still waiting to be properly answered, are (1) What is to be done in regard to the disposal of the sewage of the City of Glasgow, and the purification of the River Clyde? and (2) What is to be done with the dredgings of the river?

In recent years the latter question has frequently cropped up in Parliament, with the result that an official Government inspection has been made into the disposal of the Clyde dredgings, as at present carried on, and the effect of that system upon the lochs where these dredgings are deposited.

This inspection has been followed, like many other official inspections, by a report upon the alleged pollution of Loch Long and Loch Goil; but it yet remains to be seen what action the Government will take in the matter, if any.

The sewage question has formed the subject both of official and unofficial reports and discussions during the last twenty years or more, and in spite of all these, and also of the numerous and lengthy effusions on this subject with which the newspapers have

been burdned for years, this question remains unsolved; our noble river is filthy still, and it becomes blacker and fouler as each succeeding report comes forth, and our sewers and drains stink as they never stank before.

Some of these reports have been prepared by eminent men, and at considerable cost to the Corporation of Glasgow. The Town Council read the reports, laid them on the table, and afterwards took them to avizandum; and they have ever since remained in avizandum, wherever that may be.

Perhaps, on the whole, it is fortunate that such has been the course of procedure, and probably in the long run it will be ascertained that we have not lost anything, except the expense, through the delay in the adoption of one or other of the gigantic and costly schemes which have from time to time been brought before us.

I propose to add one more to the many contributions on this subject, not because I may have anything of importance to say which has not been said before, but rather in the hope that a lively and perhaps useful discussion will ensue among the members of this society, and that your deliberations may shed one ray of light, however dim, upon this dark though oft-considered question.

The present system of sewage disposal in Glasgow must of course be so familiar to you that it does not call for any lengthy description; but, to speak shortly, it amounts to this: The whole of the sewage is discharged into a very large settling pond known as the Harbour of Glasgow; after it has had time to settle in sufficient quantity, it is then lifted out again, removed in barges, and finally deposited in another settling pond known as Loch Long.

That is as short and truthful a description of the present system of sewage disposal in Glasgow as I am able to give, and probably when the extreme simplicity of the system is considered, any more elaborate description would be superfluous.

This delightfully primitive state of matters will most likely continue so long as we have divided authority—that is to say, so long as we have one authority in Glasgow, and about a dozen independent authorities on the outskirts of the city.

Apart from all other considerations, the settlement of the sewage question and the purification of the river point in a very decided manner to the necessity for annexation or amalgamation of the outside burghs and districts with the parent city in which they live, move and have their being. None of the burghs can

afford, neither would it be judicious on their part if they could, to enter upon a sewage scheme of their own, and it would certainly be unwise on the part of Glasgow, single-handed, and without the co-operation of the burghs, and also of the Clyde Trustees, to enter upon a scheme involving such heavy responsibilities. Perhaps I speak strongly on this point, but if annexation or amalgamation is not to be an accomplished fact in the near future, at least let the Corporation of Glasgow and the burghs shake hands over this matter, for it affects them all alike.

At this point I propose to give a short account of, and to make a passing remark upon, some of the more important sewage schemes which have been suggested for Glasgow.

Sir John Hawkshaw, Sir Joseph Bazalgette, and Mr. Bateman all proposed to intercept the sewage of the city, and transfer it to the sea, at a greater or less distance down the firth, by means of an outfall sewer; and Mr. Bateman, in a subsequent scheme, proposed to convey the sewage to Dalmuir and Braehead, on the north and south sides of the river respectively; and at these places it was to be treated chemically, so as to permit of the clarified effluent flowing into the river. The sludge resulting from the chemical treatment was to be transported in barges to the sea, and there deposited.

Another scheme, of which we have lately heard much, is to divide the city into sewage districts, to construct precipitation and manure-manufacturing works in each district, and there to clarify the sewage according to one or other of the well-known chemical processes, and to dry, press, and grind the sludge into artificial manure in the hope of disposing of it at a profit.

The last scheme to which I will refer was recently proposed by Mr. Young, the Inspector of Cleansing in Glasgow.

That gentleman proposed to adopt a system of irrigation and filtration upon several thousands of acres of land lying to the south-west of the city—in fact, to institute a large sewage farm for Glasgow, similar to those farms which obtain at Croydon, near London, and at New Derby, near Liverpool.

The various schemes which have been proposed, and to some of which reference has just been made, are all more or less open to objection. It may seem presumptuous on my part to criticise the schemes and proposals of eminent men, such as the authors of some of these schemes undoubtedly are, and it has not been without considerable hesitation that I have come to the conclusion to do so.

Does it appear very far removed from absurdity seriously to propose the expenditure of a princely sum of money with no other object in view than the transfer of the sewage from Glasgow to some other place, and there discharge it into the firth or the sea without the slightest attempt to clarify or utilise the sewage? Does this proposal suggest any such improvement on the present bad system as to warrant any expenditure whatever, and does it not contain a recommendation to practice what may be termed corporate selfishness, by seeking to impose upon our neighbours a disagreeable and offensive burden of which we are longing to be relieved?

The subsequent proposal of Mr. Bateman, to clarify the sewage and transport the sludge to the sea in barges, is not a whit better than the former. In the one case the sewage was to be conducted to the sea in its crude state, while in the other it was to undergo an expensive process of treatment, and, after all, the residue was to be thrown into the sea.

In the divided-district scheme, which has been so diligently promoted by Mr. G. W. Muir, while expense would certainly be saved through a main outfall sewer not being required, it would, owing to the number of sewage works, be more costly to supervise and work than a concentrated scheme; and then it apparently cannot be, and has not yet been demonstrated, that, almost beyond the precincts of a chemist's laboratory, the pressed and ground sludge would find a market in such quantity, and at such a price, as to pay the cost of making it, or even to go far in minimising the loss.

Mr. Young's scheme of irrigation and filtration upon land is an adaptation of the system, if not invented, at least so ably applied and worked out, by Mr. Bailey Denton, civil engineer, in London. I consider that in this system, properly applied (for success depends largely on the method of application), will be found the practical and profitable solution of the sewage question for the great majority of towns and communities in this country.

Some years ago I had occasion professionally to make an inspection of many of the sewage works in England, including both those works where the sewage is precipitated and clarified chemically, and those where the system of irrigation and land filtration is practised. I then came to the conclusion, both from what came under my observation, and from a careful study of the results and cost of the different systems, that for all ordinary towns the system of purification and utilisation upon land is to be preferred to

that of chemical treatment. My chief reasons for forming that opinion were these, that in those works where the chemical system is practised,

- (1) The effluent is not so pure as in the case of the irrigation and filtration works ;
- (2) The sludge resulting from the precipitation by chemicals accumulates at the works steadily, and cannot be disposed of even for nothing ; and
- (3) The cost and maintenance of the works, instead of tending to produce a profit, are invariably in the opposite direction.

As has been already said, the system of irrigation and filtration upon land is probably the best suited for all ordinary towns, but as there are exceptions to every good rule, there is one here also. Glasgow is not an ordinary town, but a most extraordinary city, comprising in its sewage the waste products and refuse from all sorts and conditions of manufactories and public works, and it would, in my opinion, be found practically impossible to carry out Mr. Young's scheme successfully in Glasgow without, at great cost, making an attempt to classify the sewage of the city—that is to say, to separate the waste products and refuse of many of the public works from the purely domestic sewage. It has been claimed by the promoters of some of the schemes which we have just been criticising, that their own particular scheme surpasses all the others on account of its moderate cost ; but no matter how the question may ultimately come to be solved, Glasgow must look forward to a very large outlay in this department ; and I do not anticipate, taking one thing with another, that there will be much difference between the cost of any of the systems or schemes which may be proposed.

Pumping stations for the sewage of the lower levels of the city are incidental to all the schemes referred to, and to any scheme for Glasgow which could be named, with the exception perhaps of Captain Liernur's pneumatic system (which need not be considered) ; so also are main intercepting and outfall sewers, and purification works of one kind or another incidental to all the schemes alike. The only exception in this respect is Mr. Muir's scheme, which would not, as we have already stated, require an outfall main sewer, but also it would require pumping stations, intercepting sewers, and a considerable rearrangement of the existing sewers,

so as to convey the sewage to each of the works in the various districts contemplated in his scheme. The cost of a few miles of a main outfall sewer would not probably exceed the extra cost which would be involved in the substitution of, say, four separate sewage works in the city for one work outside of the city.

The restoration of the River Clyde to a state nearly approaching its pristine purity may be said to partake more of the æsthetical than the practical, and I do not think it can be proved either that the death-rate in Glasgow has been raised owing to the impure state of the river, or, consequently, that the death-rate could be reduced by the purification of the river. At the same time, it surely cannot be said of Glasgow that she is so eminently practical and utilitarian as not to be willing to pay for anything which partakes to a certain degree of the æsthetical. But the purification of the river is not entirely an æsthetical question, as those who, either through necessity or choice, live upon its banks or travel by steamer can testify. If the pollution of the river increases at the same rate at which it has increased within the past twenty years, it will soon become a very practical evil, and passenger traffic, already greatly diminished, will entirely cease.

We have great reason to be proud of our river, because by perseverance and skill it has been converted from a fordable stream into a magnificent water-way capable of carrying the largest vessels afloat, and of bearing on its way no mean share of the world's commerce; but we have as great reason to be thoroughly ashamed of the offensive and filthy character of the water, and not until this has been remedied will we be in a position to point to our river, and say with righteous pride, "We have done this!"

At the risk of digressing from the subject upon which I have engaged to address you, perhaps you will allow me to say that in the proper ventilation and flushing of the city sewers and private drains lies one of the true keys to the reduction of the death-rate. Unless I am greatly mistaken, there is not a single flushing apparatus in one of the public sewers of Glasgow, nor is there a proper system of ventilation. The trapping of all connections with the sewers is a proper provision to make in order to prevent, as far as possible, the gases in the main sewers from entering private drains, and so getting into the houses; but why should gas be allowed to generate in the sewers, and even if allowed to generate to a certain extent, why should it not be thoroughly extracted from them?

The Government of this country would just be as culpable as the Corporation of Glasgow are in this respect, if they were to permit a foreign foe to land upon the shore, and then after the landing had been successfully effected, to request the volunteers to retain the enemy at or near high-water mark.

The main sewers are constructed so as to carry off storm waters, and, consequently, during ordinary weather, they are much too large for the mere conveyance of the sewage. As the flood waters subside, there are portions of sewage matter left adhering to the sides of the sewers. These in a short time decompose and resolve into gases, and then the mischief is done. The occupants of the houses are at once brought into a position where they are liable, if so predisposed, to contract dangerous, insidious, and not infrequently fatal diseases, from which, in other circumstances, they might happily escape.

That is a branch of the sewage question which the Corporation should be bound to face with no delay, and all the more so that it can be solved without either very great trouble or expense; and, further, as long as the Corporation of Glasgow continue to neglect the rectification of this important defect in the sewage system of the city, they will be accounted morally, if not legally, responsible for the ill-health, ay! even for the death of many of the citizens.

But, to return to the subject with which we are more immediately connected, we have before us the following circumstances:—(1) The dredgings of the River Clyde, including with them the deposited sewage from the city, are at present deposited in Loch Long; and (2) admitting that the sewage should be kept out of the river, it follows that it must be clarified. These circumstances suggest the following questions, namely:—Is the depositing of the dredgings in Loch Long the right course to pursue in the circumstances? and what is the best and most useful way of disposing of the large quantity of sludge which will result from the precipitation of the sewage?

While I do not think that the depositing of the dredgings in Loch Long is the best course to pursue, I am at the same time inclined to believe that the pollution of Loch Long and Loch Goil is not due, to any great extent, to the deposit of the dredgings by the Clyde Trustees. The dredgings have been taken to Loch Long for nearly thirty years; and it was not until Mr. Bradlaugh, M.P., became enamoured of Scottish loch scenery, and until he was supported in his views, on this question, by another gentleman

from England who recently came to live in the neighbourhood, that any formal complaints were made about pollution in these lochs. I have lived on the bank of one of the lochs for three or four months of each of the last fifteen years, and I can honestly say that I have never seen anything which would justify one in attributing the pollution to the deposit of the dredgings.

Pollution of the lochs there most certainly was, and is, and I venture to say so, notwithstanding the fact that Dr. Frankland, an eminent authority on all such subjects, has recently reported that the waters of these lochs are very much purer than the water of the Atlantic Ocean. Perhaps the learned doctor drew his Atlantic sample from astern a large ocean steamer containing the population of a small town.

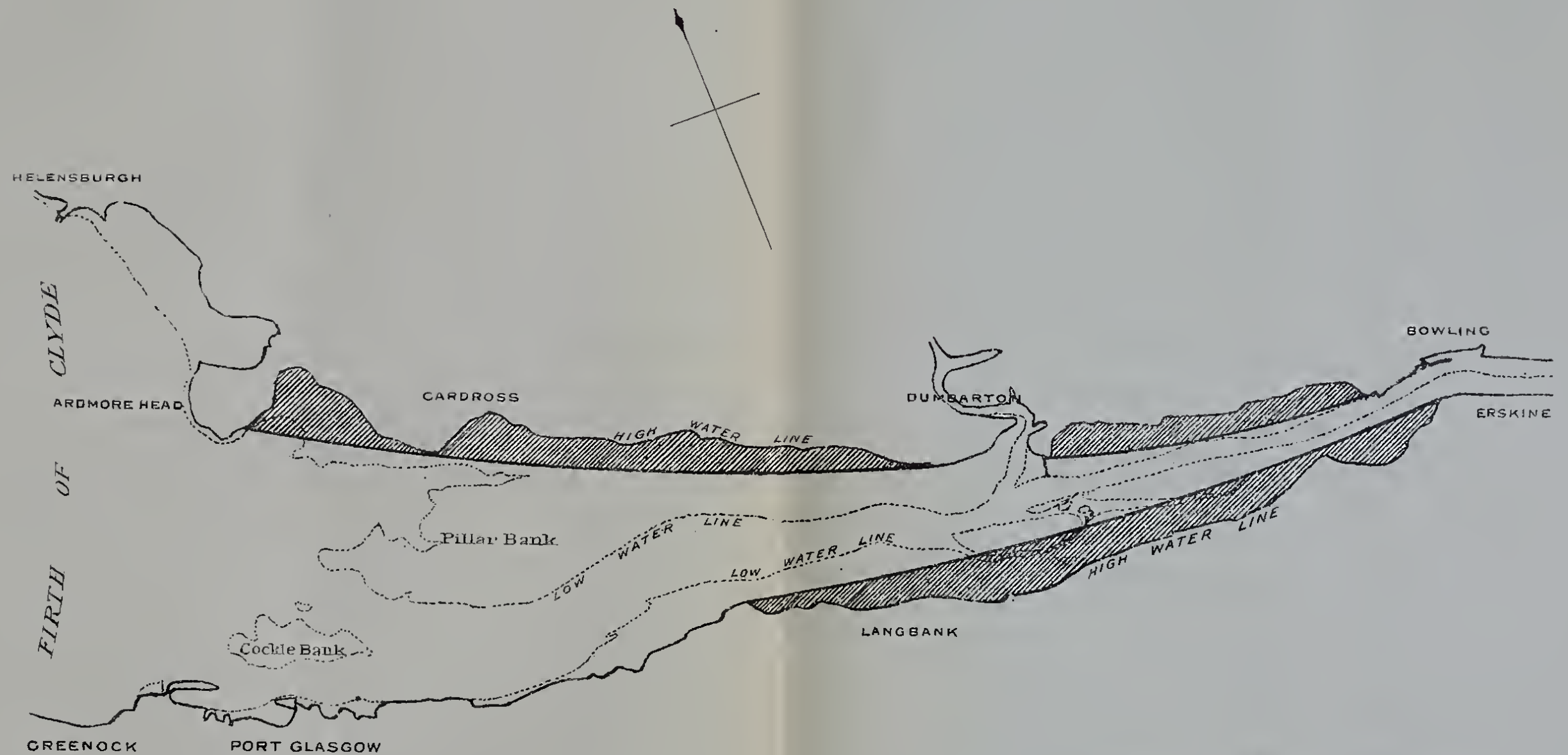
About two years ago it was the custom for a barge, laden with chemical refuse, regularly to deposit its cargo on the surface of Loch Long; but this objectionable practice has, fortunately, been discontinued. A large proportion of the pollution consists of soot and oily substances dropped from passing steamboats, and another part of it comes from the residents on the shores of the lochs.

The proposal which I intend to submit for your consideration neither contemplates the continuation of the deposit of the dredgings in Loch Long, nor the deposit of the sludge arising from the precipitated sewage in any part of the sea, as proposed by Mr. Bateman. A combination of the Clyde dredgings and the sludge from the sewage works would make rich agricultural land, and my proposal is that these materials should be devoted to that purpose in the manner afterwards to be described.

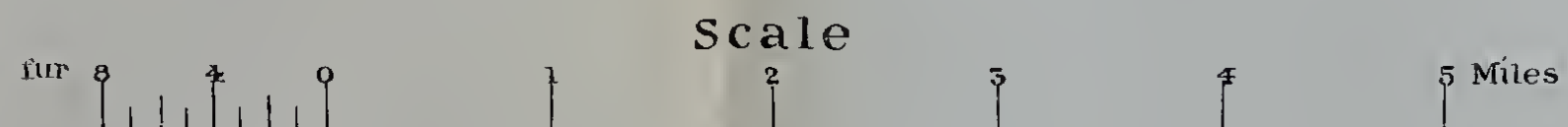
A great quantity of the fine arable land which is to be seen upon both banks of the river between Glasgow and Erskine consists of the Clyde dredgings of former years, which were deposited upon waste and marshy ground, before the present system of disposal in Loch Long was commenced. There can, I presume, be no doubt that, other circumstances being favourable, the Clyde dredgings and the sludge from the sewage would be much more usefully and sensibly disposed of by being made up into good arable land on the shores of the estuary, than by a continuance of the present system of disposal, probably followed by a similar disposal of the sludge, as recommended by Mr. Bateman.

Most of you are familiar with the Clyde Estuary, and a glance at the accompanying map will bring to your recollection that between Bowling and Dumbarton, on both sides of the river, there

PROPOSED LAND RECLAMATION IN THE CLYDE ESTUARY.
ILLUSTRATING MR. FREW'S PAPER.



NOTE— The proposed reclamation areas
are shaded thus 



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are stretches of comparatively useless and muddy land situated upon a level about midway between high and low water. Other stretches of land of the same description extend along the foreshore as far almost as Port-Glasgow on the south side, and from Dumbarton down to Ardmore on the north side. The cartoon map which is now before you exhibits, in a general way, the extent of these foreshores and the particular portions thereof which it is proposed to reclaim. The lands proposed to be reclaimed are shaded on the map, and extend to about 1,500 acres in all.

On the north side, between Bowling and Dumbarton, there are 250 acres; between Dumbarton and Cardross, 400 acres; and between Cardross and Ardmore, 180 acres; while on the south side, between points opposite to Bowling and Dumbarton, there are 360 acres; and still further west, in front of Langbank, there are 320 acres. Assuming that these waste lands are to be embanked to a level of six feet above high water, there is space for a total deposit of upwards of 29 millions of cubic yards of material.

On referring to a history of the River Clyde, prepared by Mr. Deas, the Engineer of the Clyde Navigation, and read before the Institution of Civil Engineers in London, in the year 1873, I find it there stated, that during the twenty-eight years between 1844 and 1872, the total material dredged from the bed of the river was 14,609,454 cubic yards, which is equal to an average yearly output of 522,000 cubic yards.

In order to arrive at an approximate estimate of the quantity of sludge which would arise from the precipitation of the Glasgow sewage, I have based my calculations upon the output of that material from the sewage works of Leeds, Bradford, Birmingham, and Leicester, and find that in Glasgow, taking the population at 700,000, the yearly output of sludge would probably amount to 60,000 cubic yards. Taking the dredgings and the sludge together, we have thus an estimated available annual quantity of between five and six hundred thousand cubic yards of material suitable in every respect for being used in the reclamation of the waste lands in the Clyde Estuary, but which is at present entirely lost through being deposited in Loch Long. The areas of the proposed reclamation are capable of containing the combined dredgings and sludge for a period of at least fifty years, and at the end of that period, if not sooner, our successors may probably discover some other and better method of disposing of these materials.

It is not necessary for the purposes of this paper to describe in detail the precise nature of the works which will be required for the precipitation of the sewage, neither is it necessary to consider, in the meantime, the engineering details relating to the position and levels of the main outfall sewer; but it may be stated that there are no exceptional difficulties in the way as regards the transmission of the sewage to the proposed precipitation works after-mentioned.

Generally speaking, the system of precipitation which most commends itself to me is that practised at Bradford. In this case there are a number of square settling tanks, about five feet deep, so arranged that the sewage can be turned into each tank in succession, or into any particular tank which may be desired. Before reaching the tanks, the sewage receives an admixture of pulverised lime, the process of mixing which with the sewage I need not detain you by describing at present. After a particular tank has been filled with sewage containing the precipitant, it is allowed to remain at rest for about one hour, during which time the sludge has been precipitated to the bottom of the tank.

The liquid, which is practically clear water, is then drawn off from the surface by means of a flexible syphon pipe provided with a float, which always keeps the mouth of the pipe near the surface of the water; afterwards the liquid passes first down, and then up, through two filter beds of coke, when the effluent which flows into the river is as clear and sparkling as champagne. The sludge escapes by a valve in the bottom of the tank, and is led into large reservoirs on a lower level, from which it is pumped into a series of large tanks where it is allowed to settle, after which it is removed, and allowed to accumulate in large heaps or mounds near the works.

In the case of works similar to those just described being applied to Glasgow, the process of disposing of the sludge might be very much simplified. At Bradford the object is to send out the sludge in a comparatively dry state, so that it will occupy as little space as possible, and because storage room is valuable; but in the case of Glasgow, where we propose to combine sewage disposal with land reclamation, the circumstances are not quite the same.

One of the points raised by Mr. Bateman is of such vital importance to any scheme of the kind which we are considering, that it cannot be passed over without remark—namely, will the

effluent from the precipitation works retain for a sufficient length of time, or until absorbed in the water of the Firth of Clyde, the unobjectionable condition in which it would flow from the precipitation tanks? This is a question which can only be answered by a skilful chemist, and as it has been the subject of recent correspondence in the newspapers by persons who are not chemists, and who are not therefore qualified to pronounce any reliable opinion upon it, I cannot do better than quote the opinion of so eminent an authority as the late Dr. William Wallace.

In his reports to the Corporation of Glasgow, Dr. Wallace wrote as follows:—

“A quantity of sewage taken from the Portland Street sewer was operated upon by lime in the proportion of one ton to the million gallons, as at Bradford and Birmingham, and also by sulphate of alumina and lime, as adopted at Coventry. The effluent, rendered clear in both cases by filtration through pounded coke, was mixed with eight times its bulk of clean Clyde water, that being the calculated proportion of the sewage of Glasgow to the ordinary flow of the River Clyde; and the samples were kept both in closed and open vessels for six weeks. They were examined weekly during this period, and at no time had either of them the least trace of offensive odour, while they remained perfectly clear and transparent. The quantity of ammonia was then carefully estimated, and it was found that nearly the whole of it had disappeared, while nitrates were present in considerable quantity.

“The oxygen dissolved in the Clyde water undoubtedly played an important part in the oxidation of the ammonia, and the results show that even without contact with the air, the admixture of eight times its bulk of Clyde water is sufficient to effectually oxidise, and so render innocuous, the organic matter in purified Glasgow sewage. It need scarcely be added that the crude sewage mixed with Clyde water is not oxidised in the same way.” And then he adds, “I am of opinion that the effluent may be run freely into the river at all states of the tide. I do not even consider it absolutely necessary that the works be situated so far down the Clyde as has been proposed.”

As the late Dr. Wallace was a man of great repute in his profession, his opinion upon a matter of this sort comes home to us with great weight. I had occasion to be associated with Dr. Wallace in one or two cases where his experience and advice

as a chemist were of the utmost importance, and from personal knowledge, I am therefore disposed to place great reliance upon anything he has said relating to this question.

The quotation which I have just made from Dr. Wallace's reports should be sufficient to dispel any doubt which some of us may have entertained as to the absolute safety of discharging the clarified effluent into the river. Dr. Wallace has said that it is not absolutely necessary for the sewage works to be situated so far down the river as Dalmuir, because the effluent may with safety be discharged further up the river; but it should not be forgotten that the point at which the effluent may be safely discharged is not the only thing to be considered in selecting the site of the proposed sewage works.

The land upon the river banks between Glasgow and Dalmuir is not all of the same value. It can be purchased at Dalmuir at so many pounds per acre, while in Glasgow a proprietor would never think of selling his ground at so much per acre, but before disposing of it he would carefully consider its value by the square yard. Generally speaking, the ground required for the three or four sewage works in Glasgow, as proposed by Mr. Muir, would cost about twenty times as much as the same area of land at Dalmuir, or any other equally suitable place as far down the river. For that reason, as well as for the others stated in an earlier part of this paper, the most judicious and economical site for the proposed precipitation works is in the neighbourhood of Dalmuir.

As regards the means to be employed for the transport and deposit of the dredgings and sludge to, and upon, the reclaimable areas, I propose to revert to a system somewhat similar to that formerly adopted by the Clyde Trustees for the transport and deposit of the dredgings, but having certain mechanical and other improvements introduced in order to dispense with manual labour as far as possible. The dredgings and sludge I propose to be taken to a landing stage at each of the reclaimable areas, by means of light iron punts, so constructed that they may be lifted bodily out of the water by a powerful crane, and brought to rest at the top of an inclined shoot. The material will then be discharged through a trap, opening downwards in the bottom of the punts, whence it will slide down the inclined shoot into waggons waiting for the purpose of removing it to the place of deposit. It is proposed to run the waggons along a light temporary line of railway from the landing stages to the place of deposit, as this

method would, in view of the large quantity of material to be dealt with, be more expeditious and less costly than horse haulage.

On referring to the map you will see that the proposed reclamation areas are of very considerable length in proportion to their breadth, and at first sight it may occur to you that there would be great difficulty in obtaining a firm enough bed upon which to lay down the temporary line of railway which would be moved about to suit the progress of the deposit. I propose to overcome this apparent difficulty by laying down the railway, in the first place, along the margin of the firm ground on the shoreward side of each area, and along the whole length of the particular area being operated upon. The deposit would be made from the waggons sideways, and would extend along the whole length of the area before returning again to deposit at the point of commencement. After as much material has been deposited as would be required to form a reasonable breadth from the first line of temporary railway, it will have had plenty of time to settle down into a comparatively firm state, when the railway will be shifted outwards; and another stretch of the deposit can then be proceeded with as before, and so on, until the outer margin is reached.

Before commencing the reclamation of one or other of the areas, it will be necessary to form a rough embankment, or breakwater, of rubble stones along the outer margin, something similar to the "long dyke" at present to be seen on the south side of the channel, between Bowling and Dumbarton. As the depth of water at the outer margins of the areas is not sufficient at all states of the tide to admit of the punts being towed to the proposed landing stages, it will be necessary to form a short canal or basin from the navigable channel of the river shorewards to each area, with the exception of the area between Bowling and Dumbarton, where deep water approaches quite close to the land proposed to be reclaimed.

There is still another important question relating to this scheme which demands our consideration, namely:—What effect will the proposed land reclamation, when completed, have upon the flow of water in the upper part of the river, between Glasgow and Bowling? I think I am able to say that the effect will be beneficial. It may be taken as an axiom in engineering that the gradual contraction of the cross sectional area in an estuary is the best form to produce the greatest possible range of tide and the greatest velocity in the river above the estuary.

So long ago as the year 1806, Thomas Telford reported upon the Clyde as follows—and for this report I am again indebted to Mr. Deas' admirable paper on the Clyde; Mr. Telford said:—"That in order to obtain a greater quantity of tide water in the upper part of the river, the general principle is to reduce the bed of the river to that form which shall afford the most direct course, oppose the fewest obstacles, and render the friction the least possible in regard to the section of the flowing water." An examination of the map now before you will probably satisfy you that the improved estuary lines there laid down will have the effect of operating in the direction desired by Mr. Telford. Throughout the whole course of the estuary from Ardmore up to Bowling these lines present a gradually decreasing cross section in the flow of the tidal waters, and could not therefore fail to exercise a beneficial effect on the upper part of the river. The water, which at present becomes spread out at every tide over the areas proposed to be reclaimed, would be confined and forced up the river, thereby increasing the range of tide, and consequently increasing the present low velocity of the river. An increase in the range of the tide would mean greater depth of water, without any extra dredging, and an increased velocity would tend to scour the channel, and thereby lessen the amount of dredging at present required.

Taken by itself, as a land reclamation scheme, promoted by a private company, and supposing the company to get delivery of the depositing material alongside the reclamation areas free of charge, I admit frankly, and at once, that this scheme would probably be a financial failure, because in that case the benefits to be derived from the operations of such a company would be presented to the Corporation of Glasgow, and the Clyde Trustees, and other interested authorities, at the expense of the company. Take, for instance, the increase in the range of tide, and assume, for the sake of illustration, that it would be three inches. This would produce an additional depth of water between Glasgow and Bowling which would cost the Clyde Trustees half of the cost of a whole year's dredging to obtain.

Look also at the subject from another side. The Corporation must, in the event of a sewage scheme being carried out, provide for the disposal of about 60,000 cubic yards of sludge per annum, and how could this material be put to a better use than in making up these waste lands, where there would at least be some return

for the outlay? The revenue from the reclaimed lands would be close upon £4,000 per annum for agricultural purposes only, not to speak of the probability of some parts of the lands being required for purposes which would bring a much larger revenue, as has already been the case with some of the formerly reclaimed lands further up the river.

In the event of the Corporation attempting to deposit the sewage sludge in Loch Long the residents there would probably be successful in opposing that course, and the only other course open to the Corporation would be to transport the sludge out to sea, perhaps as far as Ailsa Craig, at a cost of something like £8,000 to £10,000 per annum, or alternatively to manufacture it into artificial manure by mixing with other substances, also at a heavy loss per annum. It is also within the bounds of probability that the Clyde Trustees may require to cease depositing the dredgings in Loch Long, and in that event they also would be obliged to transport their material out to sea at great cost, involving new steam barges with greater sea-going qualities than those at present in use.

No doubt the present system of deposit by the Clyde Trustees does not cost quite so much as the former system of deposit on waste land, but if the Trustees had become vested in the waste lands at their value before they were reclaimed, instead of handing over those lands in an improved state to the riparian proprietors, they would now have been possessed of hundreds of acres of river frontage lands, the revenue from which would have gone a long way in dissipating the difference in cost of the two methods of disposal, if not in wiping out the difference entirely. In connection with this it ought to be observed that the dredgings formerly deposited on land were deposited on patches here and there, and not, generally speaking, upon any very large area at one place, and this would, of necessity, make the cost higher than it otherwise might have been.

A large proportion of the former deposits were made by wheeling in barrows from the punts moored at the bank of the river, and also by horse-waggoning, and it should be quite possible, with the improved machinery and mechanical appliances of the present time, to dispense with the greater part of the manual labour involved in this custom of thirty or forty years ago, and thus still further reduce the difference in cost between the two methods of disposal.

My suggestion, then, is (1) that the Corporation of Glasgow (and by that I mean Greater Glasgow), as well as all the Local Authorities in the valley of the River Cart and upon both banks of the Clyde from Glasgow down to Bowling, jointly with the Clyde Trustees, should, for the purification of the river, for the disposal of the sludge from the sewage, and for the useful disposal of the Clyde dredgings, take Parliamentary powers to acquire the waste lands in the Clyde Estuary at their present value; (2) that in order to preserve the access which riparian proprietors at present have or formerly had to the river, canals should be formed, or roadways, if preferable, across the reclaimed lands to the navigable channel of the river; (3) that the reclaimed lands should be subject to re-purchase by the proprietors of the adjacent lands at their improved valuation, to be determined by arbitration, failing agreement; and (4) that the cost of reclamation, as well as the revenue to be derived from the reclaimed lands, should pertain to the Corporation of Glasgow, the Clyde Trustees, and all the Local Authorities concerned in the scheme, in proportion to their respective interests, as these may be ascertained or determined by Parliament.

I have thus endeavoured to sketch out, possibly in a rough and crude manner, the outline of a scheme which, after more mature consideration, would probably tend towards the solution of the sewage disposal and river purification problems in Glasgow and its neighbourhood.

These waste and weird marshes in the estuary of the Clyde, doubtless, in some aspects, present to the eye and mind of the painter subjects which he delights to picture on his canvas, forming, as they do, a pleasing foreground in the quiet beauty of that part of our river scenery; but, beautiful as they are under certain conditions of light and atmosphere, they may yet display a more substantial and enduring charm, when crowned with a splendid harvest of golden grain, and when our meanwhile black, turbid, and offensive river, restored nearly to its pristine purity, has again become the favourite resort of the silvery-scaled monarch of our Scottish streams.